生物相容性聚乙烯基吡咯烷酮微凝胶的合成和性能研究*

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研究背景

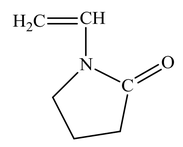
●环境响应性微凝胶其尺寸在纳米/亚微米范围内，能够对外界的刺激如温度、pH值及离子强度等产生快速响应，具有良好的生物相容性，.....。

●环境响应性微凝胶广泛应用于药物控制释放、分离技术、催化及酶的固定化等领域。

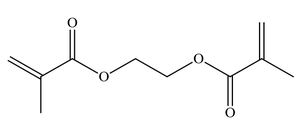
●聚乙烯基吡咯烷酮（PNVP）是一种亲水性材料，具有优异的生物相容性，是美国药监局批准的可作为药物载体的优良生物材料，但目前尚未有关于PNVP微凝胶的相关报道。

实验方法

采用无皂乳液聚合法，疏水的交联剂EGDMA能将亲水的PNVP分子链联结在一起，形成具有一定自相似形貌的 PNVP 微凝胶，该PNVP微凝胶能够在PBS缓冲溶液中可以长时间稳定、均一分散存在。



NVP



EGDMA

Table 1. The composition of series PNVP microgels.

Sample code	NVP /mg	EGDMA /mg	AIBA /mg	Product appearance
PNVP	152.1	0	10	transparent
N-E3.5	165.1	10.8	10	blue
N-E6	156	18	10	white
N-E9	156	28	10	white
N-E12	156	38	10	white
E	0	134.6	10	white

结果与讨论

1. FTIR 表征

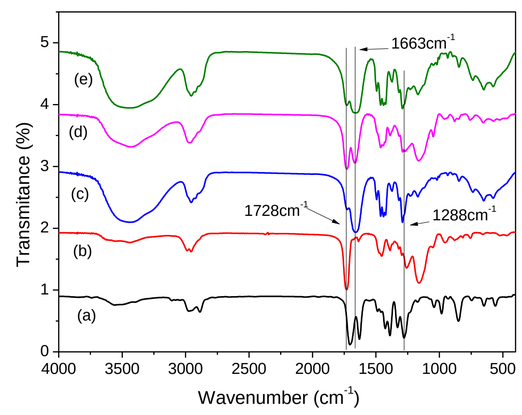


Figure 1. The FTIR spectra of (a)NVP, (b) E, (c) N-E6, (d) N-E9, and (e) N-E12 .

2. PNVP微凝胶的尺寸和表面电位

Table 2. Sizes and Zeta potential of PNVP microgels.

Sample code	DLS		SLS	R_G/R_h ratio	TEM	Swelling Ratio of D_h/D_{TEM}	Zeta potential
	Hydrodynamic diameter (nm)	PDI	R_G(nm)		Diameter (nm)		ζ (mV)
E	248.7±4	0.061	89.9±2	0.723	161±3	1.5	+26.2
N-E3.5	134.6	0.319	76.2±4	-	97±18	1.38	+13.3
N-E6	192.4±2	0.098	80.7±2	0.84	114±12	1.68	+31.9
N-E9	213.1±1	0.071	98.1±4	0.92	115±5	1.85	+31.5
N-E12	203.0±2	0.042	79.1±1	0.775	150±17	1.35	+20.4

3. PNVP微凝胶的形貌

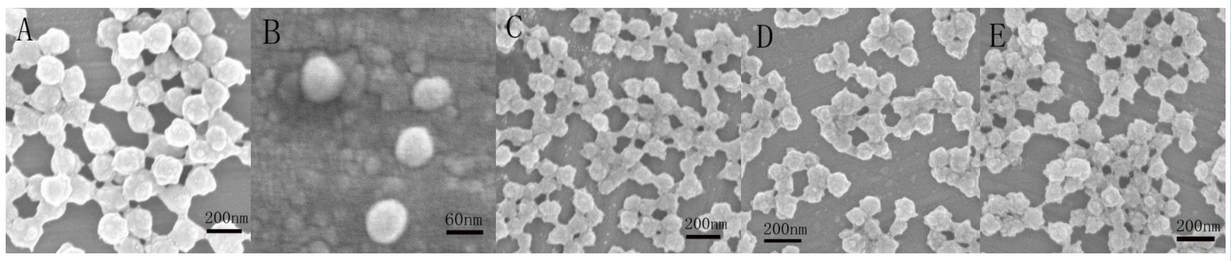


Figure 2. The SEM images of (A) E, (B) N-E3, (C) N-E6, (D) N-E9, and (E) N-E12.

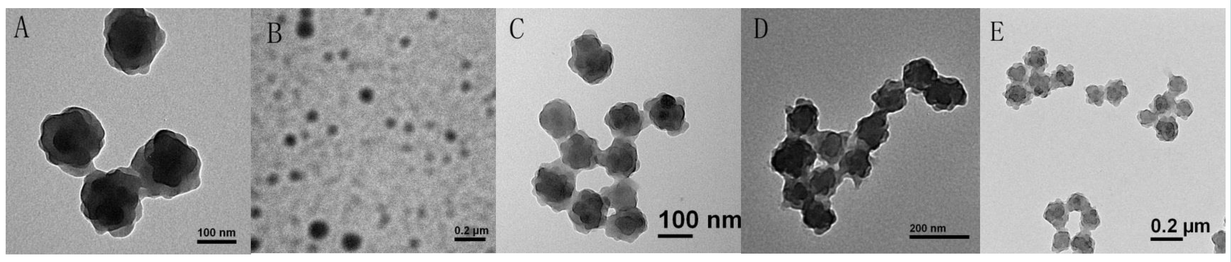


Figure 3. The TEM images of (A) E, (B) N-E3, (C) N-E6, (D) N-E9, and (E) N-E12.

4. PNVP微凝胶的MTT细胞毒性实验

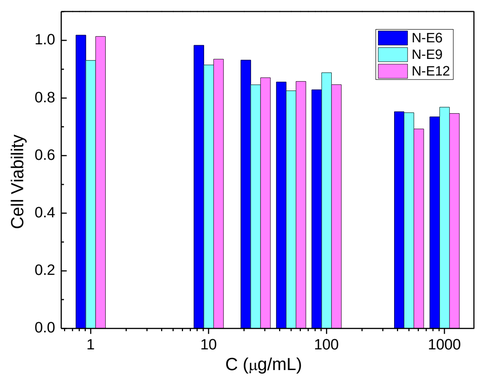


Figure 4. Viability values of HEK-293 cells in the presence of PNVP microgels with concentrations ranging from 1 to 1000μg/mL as measured by MTT test.

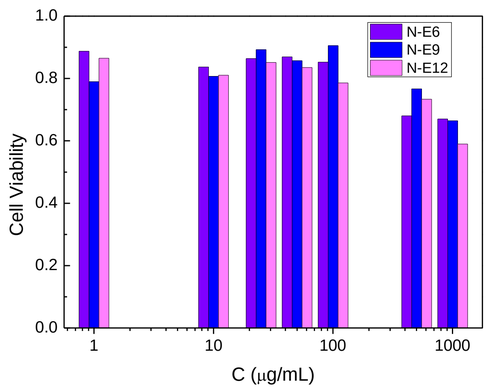


Figure 5. Viability values of MCF-7cells in the presence of PNVP microgels with concentrations ranging from 1 to 1000μg/mL as measured by MTT test.

5. PNVP微凝胶的载药及其缓释

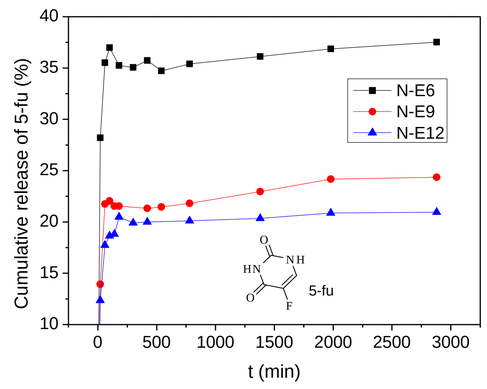


Figure 6. The cumulative release of 5-fu of (■) N-E6, (●) N-E9, and (▲) N-E12.

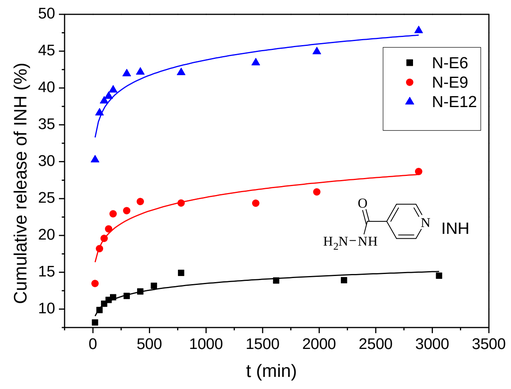


Figure 7. The cumulative release of INH of (■) N-E6, (●) N-E9, and (▲) N-E12.The solid lines are the fits with Ritger-Peppas equation (y= kt^n).

小结

●成功制备了尺寸均匀的聚乙烯基吡咯烷酮（PNVP）微凝胶；

●PNVP微凝胶具有自相似的形貌结构，通过SEM和TEM均可证明；

●PNVP微凝胶具有很好的生物相容性，能够有效的对药物5-fu和INH进行载药和缓慢释放，其中INH的释放符合Fickian释放模型。

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